IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Gurin et al.

Application No.: Examiner:

Date Filed: Group:

For: ALKALINE ELECTROLYTE FUEL CELLS WITH IMPROVED HYDROGEN-OXYGEN SUPPLY SYSTEM

CERTIFICATE UNDER 37 CFR 1.8(a)
I hereby certify that this correspondence is being deposited with the U.S. Postal Service as First Class mail in an envelope addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on 2/24/04.

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PETITION TO MAKE SPECIAL UNDER 37 C.F.R. § 1.102(c)

Mail Stop Petition
Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

Sir:

Pursuant to 37 CFR §1.102 and MPEP 708.02, Applicants hereby Petition to Make Special for an advancement of examination the above-described United States Patent Application. Since the above-referenced Application is believed to qualify under 37 C.F.R. § 1.102(c), this petition is filed without fee. However, should a fee be determined to be required, the Commissioner is hereby authorized to charge any deficiency in any fees due with the filing of this paper, or during prosecution of this application to Deposit Account No. 50-0951.

Applicants request special status for the referenced application on the basis that the claimed invention will "materially contribute to the development or conservation of energy

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resources" as recited in 37 C.F.R. § 1.102(c). Specifically, the invention provides reliability, efficiency, and stability improvements for alkaline fuel cells (AFC) resulting from the improved reactant supply system designs described therein. Through these improvements, AFC fuel cells may become a better choice then the now favored PEM fuel cell (Proton Exchange Membrane) for commercial applications including electric vehicles and on-site power generator systems. Although convention AFCs have been shown to be more efficient and produce a higher cell voltage (0.8 v) compared to PEM cells (0.6 v), the achievable cell lifetime has limited the application of AFCs.

Specifically, conventional oxygen supply systems in AFCs are known to generally determine their reliability. Water-free oxygen is fed into the fuel cell stack (FCS) at the single inlet point ("dead end") from cryogenic storage tank(s). In operation, the FCS temperature is generally between 20 and 95 degrees C, and the vapor partial pressure above the electrolyte (KOH/water solution) is as high as 45 – 60 KPa. This condition causes intensive water evaporation at the oxygen entry area to the cathode and matrix, which in turn, leads to increases in local electrolyte concentration in the cathode, matrix pores, and anode. This also accelerates the rate of localized matrix corrosion. Resulting formation of large pores and low electrolyte capillary pressure in localized matrix zones may even fail to prevent direct mixing of hydrogen and oxygen within low operational times, such as 300-500 hrs.

An AFC according to the invention includes an alkaline matrix electrolyte interposed between a porous anode and porous cathode, and an oxygen flow network in fluid connection with the porous cathode. The oxygen flow network has an input portion for supplying oxygen and an output portion for removing oxygen and reaction products after electrochemical reaction. A hydrogen flow network is in fluid connection with the porous anode. The hydrogen flow

network has an input portion for supplying hydrogen and an output portion for removing hydrogen and reaction products after electrochemical reaction. One aspect of the improved reactant design according to the invention relates to the inclusion of at least one of an oxygen flow recirculation loop and a hydrogen flow recirculation loop. The recirculation loop feeds back a portion of the hydrogen and/or oxygen flow after electrochemical reaction to the respective input portion.

When an oxygen recirculation loop is provided, the oxygen recirculation loop provides a humidified flow to the input portion of the oxygen flow network by feeding back a portion of the oxygen saturated with water vapor from the cathode outlet to the cathode inlet. This arrangement avoids, or essentially eliminates, normal water evaporation from the electrolyte in the cathode inlet region and resulting degradation of inlet region of the fuel cell. The volume of the humidified flow is preferably adjustable, the humidified flow volume increasing with a load on the fuel cell. A jet pump can be included in the oxygen recirculation loop, the jet pump inducing recirculation in the oxygen recirculation loop.

In a related embodiment, the fuel cell includes a flow modulator fluidicly connected with at least one of an input portion the hydrogen flow network and an input portion of the oxygen flow network, wherein the modulator provides a time varying mass flow of the hydrogen or oxygen. The modulator is generally operative across all fuel cell load conditions. The reactant flow resulting can be characterized as a pulse gas supply and recirculation where the pulse dynamics change as a function of load. For example, pulsed hydrogen supply to the fuel cell stack anode provides significant advantages including continuous replenishment of the current-generating surfaces within the anode, while providing active removal of impurities from the

anode gas transporting pores. Using load dependent modulated flows, the efficiency of the AFC has been found to be significantly improved.

Data is shown in Table 1 which quantifies significant improvements in internal power consumption, rate of degradation of performance, and service life of an AFC stack according to the invention as compared to a conventional AFC stack. Efficiency improvements result in significantly reduced weight requirements for the fuel cell stack on a per-watt basis. The high efficiency, together with long stable operating lifetimes and high reliability provided by the invention is expected to permit fuel cells according to the invention to be useful for a wide variety of commercial applications, including possible use in electric vehicles. Thus, based on data obtained from AFC stacks according to the invention, the invention is expected to provide more efficient utilization and conservation of energy resources as recited in MPEP 708.02 and 37 C.F.R. § 1.102(c).

Applicants hereby assert that a pre-examination search was made regarding the subject matter claimed in the present application. The field of search related to AFC fuel cells, with regard to published U.S. patent applications and U.S. patents.

The following related U.S. patents were identified in the search performed:

1. U.S. Patent No. 6,569,552 to Kato et al.
2. U.S. Patent No. 6,656,620 to Katagiri et al.
3. U.S. Patent No. 6,093,502 to Carlstrom Jr.

Kato et al. disclose a fuel cell system which includes a fuel cell (FC stack), an inflow passage valve provided in a hydrogen inflow passage through which hydrogen is supplied to the FC stack, and a discharge passage valve provided in a hydrogen discharge passage through which hydrogen containing gas is discharged from the FC stack as exhaust gas. In the fuel cell,

hydrogen is supplied to the FC stack intermittently in accordance with an amount of hydrogen consumed in the FC stack, by controlling opening and closing of the inflow passage valve and the hydrogen discharge valve.

Katagiri et al disclose a humidification system for humidifying a fuel cell including a water-permeable-type humidifier for humidifying reaction gas used in reaction with moisture in exhaust gas exhausted after the reaction; and an adjuster for adjusting an amount of humidification to the humidification amount required by the fuel cell.

Carlstrom Jr. discloses a fuel cell assembly including one or more (e.g., PEM-type) fuel cell(s). Fluid(s) service(s) for the fuel cell assembly may include reactant fluid(s) service(s) such as service(s) of fuel(s) and/or oxidant(s), along with humidification service(s). A pulsator may be positioned at any entrance and/or exit for the fluid manifolds. Such pulsator(s) may serve to introduce pressure variation(s) along part(s) of flow path(s) extending in the fuel cell assembly. In one example, with respect to an anode side of a fuel cell, the pressure variation(s) may serve to purge a nitrogen blanket from the anode side of the MEA so reformate including hydrogen may be supplied for electrochemical reaction. With respect to a cathode side of the fuel cell, the pressure variation(s) may serve to remove a nitrogen and/or carbon dioxide blanket and product fluid from the cathode side of the MEA so air containing oxygen may be supplied for the electrochemical reaction. Also, excess humidification fluid may be removed. A greater power density may be obtained. Pressure variation(s) may be configured to dynamically inflect the MEA to assist mechanical mixing(s) in promoting flow field fuel service(s) and/or increasing power density.

Detailed Discussion of the References Which Points Out With the Particularity How the Claimed Subject Matter is Patentable Over the References

None of the above references identified by Applicants noted above disclose or suggest a recirculating reagent fuel-cell arrangement where a recirculation loop feeds back a portion of the hydrogen and/or oxygen after electrochemical reaction to their respective input portion. Thus, the closest art known to Applicants is general AFC fuel cell art represented by relevant fuel cell related papers and the patents and patent applications regarding the same.

Regarding the modulated reactant flow embodiment described in the present invention, U.S. Pat. No. 6,093,502 to Carlstrom, Jr., which in contrast to the invention relates to PEM fuel cells, is believed to be the closest art known to Applicants. Although U.S. Pat. No. 6,093,502 to Carlstrom, Jr. does disclose a pulsed reactant system, a significant difference between the reactant flow characteristics obtained using devices disclosed in the present application as compared to pulsed reactant systems such as disclosed in U.S. Pat. No. 6,093,502 to Carlstrom, Jr. et al. is the simultaneous variation of pulse width and pulse period in relation to the external load and gas consumption rate of the electrochemical reaction provided by the invention. In addition, Carlstrom's pulsed system is only activated upon detection of a predetermined high load level, while the pulsed gas supply of the invention is preferably operable over all load conditions.

Applicants hereby submit one copy of the above-referenced patents together with an Invention Disclosure Statement filed herewith which are deemed to be the most closely related art to the subject matter encompassed by the present claims known to Applicants.

In order to help expedite bringing this important technology to the market, Applicants respectfully requests a timely grant of this petition to make special for an advancement of examination under 37 CFR §1.102(c) and MPEP 708.02.

Respectfully submitted,

Date: 2/24/04

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